U.S. EPA Meeting with Penn State (phone conference call)

May 20, 2016; 11:00 AM – 12:00 PM
One Potomac Yard
2777 Crystal Drive / Arlington, VA 22202
Room S-6771

FINAL MEETING MINUTES

Attendees: Chris Carusiello (**CC**), Ksenija Janjic (**KJ**), Jacqueline McQueen (**JM**), from US-EPA; Patty Wong (**PW**), Joselyn Claude (**JC**), Emily Wang (**EW**) from Cal-EPA; Andy McNitt (**AM**), Tom Serensits (**TS**), from Penn State.

Andrew McNitt: Professor of Soil Science and Director of Penn State's Center for Sports Surface Research

Tom Serensits: Manager of the Center for Sports Surface Research

CC: Purpose of this call is to better understand the construction, maintenance and operation of synthetic turf fields, to comprehend any potential variability and recognize certain trends in the industry.

CC: To start out, can you tell us about the program at Penn State, how it began, and who the target audience is?

AM: At Penn State, we have a long history of natural turf grass research that started in the 20s, and then we started doing education in the 50s. We have the largest facility and largest enrollment of students, so we have graduates all over the world. They are taking care of Augusta National, the PGA championship this year, and we were doing natural grass research. In the late 90s, when the infill systems came out, we were getting a lot of questions from our alumni who were working in the NFL, colleges and high schools. Both Tom and I consult for the NFL, we run their surface certification program: every game field has to be certified prior to every game. Tom has a team of people who go out and test those fields, and we sit on several committees at the league level and advise on maintenance of the field for safety, etc. Our goal has always been to provide, number one, safe and playable athletic fields. In the late 90s, we started to get questions on this, and cobbled together some grants to do some research. And again, our research is not on toxicology, we're not toxicologists, but we do characterize surfaces, and work with some biomechanics people on the ways in which an athlete interacts with those surfaces, and what we can do as field managers to improve that surface. So we started to look at the various infill systems. In 2006 or 2007, FieldTurf came to the university and wanted to gift money to the university to create the Center for Sports Surface Research (they liked the research we were doing). We do not have a contract with them, we have never done contract research with them. They gifted a startup grant for us to do more research in that area. So we continue to do natural grass research and synthetic turf research as well, looking at the various combination of fibers, and infill and paddings, how to maintain them to get good player to surface interaction.

TS: We do lot of traction research in terms of injury and playability, looking at different systems and tweaking different aspects or properties of the systems whether it be the infill or the fibers. We do a lot with surface hardness with head injury issues. We are looking at ways that we can make the field playable, but still pass certain test levels and thresholds. We look at fiber durability of synthetic turf, abrasiveness, how management practices effect the overall integrity of the surface in terms of safety and playability. Surface temperature is another big issue we look at - different ways to lower surface

temperature. Those are the overarching type of things that we do. We'll test traction on synthetic turf versus natural grass and the changeover variabilities in natural grass as well. So it's looking within synthetic turf and comparing it to natural grass as well.

AM: All of our research is controlled and owned by us so it's in the public domain. There's no research being done for an individual company.

JM: I noticed that you do some microbial research.

AM: We did. I found high schools spending as much as $30,000 per year disinfecting fields, and while I'm not a bacteriologist, I knew a little bit about bacteria and realized that MRSA does not want to live on inanimate objects (its ideal survival temperature is 98.6 degrees Fahrenheit—it wants to live on human beings). I really felt like these high schools were wasting their money on antimicrobials so we did some research first as a survey, because these companies were claiming that this was an ideal environment for staph to survive and multiply—which we knew was wrong. So we did a survey first and went out to 20 high school fields and tried to find staph and couldn't find them. That study was criticized, they said "maybe you were there at the wrong time, maybe this and that," so we said "OK let's apply it and look at these antimicrobials and see how long staph will survive." Outdoors we found 99.9% of all staph applied was dead in under an hour. The vast majority was dead in the first 15 minutes. And at first we assumed it was due to heat because these systems do heat up, but as we researched further we found light was an excellent disinfectant. So on outdoor fields, we found that the staph would not survive under even moderate light intensities. We moved the study indoors and set up an ideal condition where there was no light, it was a completely dark room with high relative humidity. We were doing everything we could to sort of favor staph survival, and found that we could detect live staph after 11 days in one trial and 14 days in another. We would put 60,000 colony forming units (CFU) per square centimeter and we were finding one maybe after 11 days. We also did that with natural grass indoors side by side and it survived on the natural grass almost in the identical amount of time. We have not repeated that study in a more realistic situation where there is some light. The relative humidity would not be as high. My understanding is that the CDC still does not support the widespread disinfecting of indoor synthetic turf. The NFL did its own independent study with bacteriologists and a lot of people smarter than me in that area and came to the conclusion that there was no benefit for large scale disinfecting, and as a matter of fact, any potential dis-benefit would outweigh the benefit of disinfecting. We also found that the best disinfectant was liquid Tide, or it was as good as any of the much more expensive ones. And they were making wild claims that you could spray it, and it would be "bacteria free" for 6 months. And of course, common sense says if you have a product like that, shouldn't you be targeting hospitals? Why are you marketing it to synthetic turf people? We found that those products acted very similar to a detergent. We brought in other university consultants on that, a microbiologist and a pathologist, to advise us and make sure our methods were good because that's not our area of expertise.

KJ: How did you end up messaging your research and what is the status right now? Are still some high schools potentially using the disinfectants, or are none?

AM: Some do, we believe that there are fewer. Some call us still, they say "we want to do anything we can just to make sure we say we tried." My advice is just to spray some liquid detergent. That it would work as well as anything. But if you spray liquid detergent today and tomorrow you have an event, and an athlete has MRSA and deposits on the surface, what you did yesterday doesn't matter. So they deposit it, then you have someone fall on it. Our review of the literature indicates that there has never been a documented case where someone has obtained MRSA from the field. There has been some research done that synthetic turf is more abrasive than natural turf, there are more breaks in the skin, and thus, if you

play on synthetic turf and you have more breaks in the skin, you have a higher chance of getting it from another person. But you're not actually getting it from the synthetic turf. And so even in some practice fields in the NFL, their trainers are requiring them to treat. But in the game fields, the league has said, they're not allowed to treat them.

KJ: Is there a difference in these practices depending on indoor fields and outdoor fields?

AM: Tom, I don't know, we don't have that documented. There's also a UV light treatment that is towed behind a vehicle, with large UV lights, and we've done some research on that that and showed that it works very well. They are sometimes treating fields with UV light. I think that's probably the least common because of expense. I would say less than 10% are treated on any kind of regular basis. I think the practice is not that common, but it is out there.

TS: We don't get any feedback or questions regarding that really. At least I haven't in the past few years. There doesn't seem to be too many questions anymore on it. I'm not sure how widespread it is used, due to cost.

AM: I probably receive five requests a week, every week for information on synthetic turf of some type or another. I probably get five calls a year regarding disinfecting a field.

CC: Is there ever any need to use an herbicide or pesticide on a synthetic turf field?

AM: Very little, occasionally someone might spot treat out some weeds here or there. There's never any widespread use of a pesticide on a field that I'm aware of. In the UK, and Pacific Northwest to a lesser degree, sometimes the field will get some algae on them. It has to be a very cloudy, raining environment for the rest of the United States, so it's almost unheard of. So I've heard of cases where they're treated for algae. But in the U.S., other than the Pacific North West, I have never heard of algae being a major problem.

TS: Sometimes you will see sprayers out there. There are other products you can put out using a sprayer. Sometimes static electricity is an issue in new fields where the crumb rubber wants to stick to the blades, so there's different surfactants and things that can be sprayed out there. Essentially just laundry detergent, things like that, fabric softener to break down the static. Sometimes they'll spray a wetting agent or surfactant. Sometimes the infill gets hydrophobic and the water doesn't want to go in. so sometimes they'll put out a surfactant or wetting agent, which is commonly used on natural turf, essentially just a soap to help break the surface tension of water so it goes down in. So you may see sprayers on the field, not putting down pesticide or herbicide, but just as an overall maintenance practice.

CC: Can you touch on how geographic differences influence maintenance practices?

KJ: Do frost, rain, or excessive heat influence maintenance practices?

AM: Certainly synthetic turf gets excessively warm, but it's not a very good heat sink. And that's why it's warm, because it's getting reflected. So the surface gets warm, but the air temperature above the surface doesn't get very much warmer, but it's the surface itself that gets warm. Only because of the bright sun. When you have a hazy day the surface does not get warm, but when it's contacted by bright sun it will get very warm. We've noted that even when a cumulus cloud goes over, it can drop 30 degrees in ten minutes. It heats up quickly and cools down quickly too. I'm not sure if it contributes much to an urban heat island because none of the heat is stored. For example, if we get a light snow, snow will begin to melt on the grass at nighttime faster than it will melt on the synthetic turf because the synthetic turf will be colder than the grass. As soon as the sun comes up that flips, and all of the sudden the synthetic turf

will melt a light snow covering faster than the grass does. Because it heats up quickly and cools down very quickly. So in sunnier areas, athletes, trainers and coaches need to be more aware of the time that you will expose athletes to that heat. There are studies that have been done in the 70s that have shown that a warm synthetic turf surface does transmit enough heat through the shoe, and that the athlete has to dissipate that heat.

Some of the better colleges and pro-teams have essentially a mini weather station that they will set somewhere on the sideline looking at humidity, wind speed, surface temperature, etc. So the trainer can say, "Hey coach, only 20 more minutes on this surface or we either need to change surfaces or give them a break." We don't have that many bright sunny days in central PA. Any place like that would certainly affect the heat.

Other maintenance, we discourage it, but they do try to plow snow off of surfaces. Snow removal is a very tricky thing. You can damage the surface. Certainly you'll remove crumb rubber or you'll remove it at a faster rate than typical play would remove it, and so then that crumb rubber would have to be replenished at a more frequent interval compared to not removing snow.

TS: I think synthetic turf companies tend to discourage any grooming during extreme temperatures (cold of very hot) as much as they can. And I think in terms of the cooling of the synthetic turf, some places irrigate the turf to cool the temperature. Some of the research we've done related to the question: How long does that cooling last? If you have a bright sunny day, in about 20 minutes the temperature rebounds up to within 10-15 degrees of what they were before you've irrigated—and now you've increased the humidity above the surface. Some people do that, it's not really effective. There's really nothing out there that's any better. That nut hasn't been cracked yet, in terms of cooling the fields for 3 hours (the length of the game). As soon as that surface layer dries, the temperature goes right back up.

AM: Heat is very important to us and right now we don't see any reasonable technology on the market to mitigate the heat issue. And it's only an issue when it's a clear, sunny day.

TS: While we're talking about maintenance practices, I think that there are some geography differences like we talked about, but a lot of differences are how heavily the field is used. So if it's a very heavily used field, it's going to need to be groomed more often. The infill depth levels need to be checked on a greater frequency. As infill levels drop, and we know that they drop because they are leaving the field, the fields would get harder and we used to think because the crumb rubber gets compacted. But in nearly all cases, the particles are very uniform in size so they don't want to compact very much. Really what we see in terms of hardness increasing, is the infill actually leaving the field. In heavily used fields, say a lacrosse goal mouth for example, that infill depth decreases over a relatively short period of time in a few cases. So a maintenance practice would be to check the infill depth, then know where you need to be from the manufacturer, then add more crumb rubber infill in those areas to maintain that depth. A field that is being used like a high school field, where you have multiple teams sharing the same field, is going to require more maintenance than a field that's used less frequently.

AM: Let's talk about the manpower needed in the 3 biggest maintenance practices: One, most manpower is used in brooming the field to keep the fibers standing up so they don't mat over. On heavily used fields, that's done at least weekly. So they broom the field instead of mowing it, they drag a broom across it to stand all the fibers back up. On natural grass we aerate the field, by pulling out cores a couple times a year, they will drag springtime rakes across the field just kind of loosening up the granules, we don't find that that affects the hardness of the field very much. Third, topdressing of fresh crumb rubber. This is a maintenance procedure not being done enough in our mind. In 2011, only one NFL field was doing that on a routine basis, prior to the certification program, now they're all doing it. Periodically, they have to

come up with new crumb rubber and replenish it. Surprisingly, it's not that often, removal of snow will increase that. Tom, I agree that in front of a lacrosse goal mound gets displaced. A good install probably doesn't need topdressing the first two years on most fields. We were tracking a field here, a brand new high school field that gets a lot of play. Over the first year or two, you saw almost no removal of crumb rubber.

TS: And there are exceptions. For a synthetic turf baseball field for example. We're starting to see that more in the north colleges. The sliding area at 2nd or 3rd base, the infill isn't necessarily leaving there, it's just getting pushed out. Or in a tunnel entrance for example, we see those areas having problems keeping hardness in check, because that infill is getting moved around. In pockets where it's very heavily used, you have to pay frequent attention to it.

AM: Really we don't usually see the need to replenish for the first 2-3 years. Then you might put some down, you might be good for a year, two years. But I don't want to give impression that they're having to put fresh crumb rubber down monthly or weekly. It's really annually, or every two years, when they need to put some more crumb rubber down.

TS: Maintenance practices for organic infill is different than on crumb rubber fields. It is not fully known what is needed, those have the potential to compact more so there may be more de-compaction procedures.

AM: Some companies are recommending pulling out all that organic matter each year and replenishing it with fresh material. Although, we're looking at some organic materials we think might hold up longer. The research on that and practical experience is almost nonexistent because the products are fairly new and not in high use.

CC: Going back to the topdressing. Would you have to replenish everywhere on the field after two or three years, or just pay attention to some of the high use areas around the goals or kicking area?

AM: Right, and those areas tend to be small: in a kicking area you're talking 2, 3 square feet. That's what we suggest they do, what happens in practice other than in NFL fields, where they're monitored and have to put it in, is a completely different story. We see very little topdressing being done. We're actually trying to encourage it because it makes the field softer and we hope it reduces concussions. But getting people to do it, the awareness is a new thing; we're trying to increase the awareness. Tom if you had to take a wild guess at how many crumb rubber fields are being top-dressed what would be your guess?

TS: Less than 15% I would guess.

AM: I think it's lower than that. I'll bet it's under five. Let me take that back. Under five is they're doing routine topdressing or maintenance. Fifteen percent would be at year six, they have done nothing to the field, and at year six they hire a company to come in and sort of replenish everything and stand the fibers up. If we include that, then it might not be as high as 15, but it may be approaching 15%. The vast majority are not doing that practice, although we wish they were.

JM: Do you mean among colleges or high schools?

AM: I'm including all synthetic turf fields in the United States.

JM: It seems like the professional fields would have to do that routinely, right?

AM: Prior to 2011, only one NFL field was doing that routinely. Now, all the game fields are required to do it. We monitor them and make them do it. But I think we would be shocked if we looked at Division 1 NCAA football synthetic turf fields at how few of them are routinely topdressing.

TS: The problem too is that a lot of places will neglect it for six years and then they realize they have a problem. Then they want to add infill, and by that time the fibers are so degraded because the infill was so low to begin with-- it's very difficult to get the infill into the field. So people, once they get to the point where the field starts to wear out, realize they need to do something. It's a lot more difficult than if they were on top of it at install moving forward, doing routine maintenance, adding little bits at a time

AM: There's still a misconception out there that many people, probably the vast majority, believe that the fields get hard because of compaction. Really the fields get hard because the crumb rubber slowly disappears.

KJ: I had two questions: one regarding what the typical lifespan of the field is, is it likely that a field would last only six years? Regarding the compaction, does it differ between the cryogenic and ambient-processed crumb rubber?

AM: We've never really seen a difference in ambient versus cryogenic rubber as far as compaction goes. It's not so much how it's manufactured, it's how it's sized. If you have a quality company, and they have a fairly uniform size, and they get their sand to crumb rubber ratio correct, then my opinion is that we've never seen a difference between ambient and cryogenic.

Fields will break down through photo degradation—the sunnier it is, the quicker the plastic is going to break down. Thus if you have less infill, you have more fiber exposed, so it breaks down. It's pretty standard for the industry to have an 8-year warranty. I don't see many going less than 8 years. And I see a good number of them trying to extend that to 10. I've seen some pros going 10 and 11. Our experience is, if you keep your crumb rubber up at 8, 9, or 10 years, while the field might look bad, playability is still pretty good, because the fibers that matter for playability are the ones down in the crumb rubber, not necessarily the ones sticking up. Fields are replaced a little more often in the NFL, typically because they have concerts on them, and that degrades the surface more so than athletic events. But I don't see many high school fields being replaced in less than eight years, do you Tom?

TS: No, I don't think so. In extreme environments like Hawaii or Las Vegas, you might have to do it a little quicker because of UV degradation.

CC: Do you know of any high use areas that needed to be filled more often than others?

AM: The batter's box around home plate will wear out very rapidly. They actually make the batter's circle a separate piece so they can take the whole batter's circle out and put a new one in there. The lacrosse goal mounds are notorious because of the cutting that occurs. It's not necessarily where the goalie stands, but sort of the ring outside of the goalie that needs to be replenished more often. And the second base sliding area, and the lead off area off of first base.

TS: What an inlay is, you have your green carpet, instead of painting your field markers, they'll put in colored carpet. In certain circumstances, they'll take sheers and sheer down the green fibers to the backing and then glue the new colored piece of carpet on top of it, so what that does is you have less room to put your infill cushion because you have your backing glued to your backing. So instead of 44 mm of infill you have maybe 38 or something on those inlays. Because of that, you have less cushion so they tend to be the most hard.

JM: What is the difference between ambient and cryogenically produced crumb rubber?

TS: We've done a number of different studies in terms of playability, and we haven't found really any meaningful differences between the two in any of the characteristics that we've looked at.

KJ: Can you talk about the differences in the different product systems?

TS: The reason sand is included is because it feels more firm on the foot for the athlete. So if you put 100% rubber down, it tends to be more shifty and spongy. Most athletes would prefer a firmer surface on the foot. That's kind of the idea behind adding sand. If you add too much sand, then you're going to have issues with hardness. So basically you're adding sand for firmness on your foot. In the realm of what is reasonable, we're not seeing many differences in terms of traction and things like that. We know that as you add more sand, you have a higher potential for a harder surface. Assuming you have a reasonable amount of sand, no reason that a sand / rubber mix can't perform well, as long as it's maintained well. In terms of sizing, typically a fairly uniform, fairly coarse sand is used as well.

AM: And it's a silica sand. Your other questions such as, do they wear out, do things need to be replenished at a different rate - we have not seen any differences along those lines. We're not recommending all sand infill. It was first introduced in the early 80s or 90s and they all needed a pad underneath them, and they don't make a very good play surfaces. As long as we're within a certain range, for playability, there are no real meaningful differences. It's really a perception of the athlete, they want a firm, fast field. It's used as a maintenance practice in the NFL, top-dress with sand or crumb rubber depending on hardness/sponginess.

KJ: Does it seem like there are any fields being installed with just crumb rubber today?

AM: For a while, it was just a patent issue with FieldTurf. In the early 2000s and mid 2000s you saw a lot of straight crumb rubber fields going in, then I think their patent expired, and so now it seems like they're a mix. I think almost all of them now are mixes. The technique is pretty similar regardless of which fields you go to look at.

TS: Some of these short pole systems, where the fibers are just an inch or maybe less. That may be a thin layer of crumb rubber over a pad.

AM: There aren't many of those going in.

KJ: Where would you see that kind of system? Who would put it down?

TS: It's a cheaper system, maybe lower-end recreation or playground perhaps, and that's just a guess.

AM: In the professional fields, sometimes they'll use that on the track that surrounds the field, they don't expect the athlete to interact with it, but they drive vehicles on it so they want something cheaper without a lot of infill. The install isn't very different, as far as the process goes, just using less crumb rubber.

KJ: What are the typical ratios of the crumb / sand mixtures?

TS: FieldTurf by weight (sand weighs more than rubber), it's about 2/3 sand, 1/3 rubber; but by volume it's 60/40, 60% crumb rubber, 40% sand by volume. 9.2 lbs of total infill per sq. ft. with 6.2 lbs sand, 3 lbs being crumb rubber. Some do 50/50. But that is FieldTurf. Maybe up to 75% sand, but the 2/3, 1/3 is a general average.

CC: Are you aware of the market distribution across the US, how many fields are in each state or region?

AM: We used to have the information for the fields, but I do not have a distribution.

KJ: Are you aware of any specifications for the age or types of tires used for infill?

AM: You have truck and cars, and separating the two is difficult. I don't know too much about the process. Cryogenic is freezing then breaking, ambient is shredding. It depends on the sizing so that it doesn't want to compact, and that it has a high porosity and drains well.

CC: What kind of research are you currently undertaking or planning on doing in the future?

TS: A lot of our research revolves around traction, we're doing a lot with different shoes. In the past, we tended to think there were big differences in natural and synthetic fields. What we're finding now is the cleat pattern is actually a very important aspect in terms of safety. So what we do is measure rotational traction, so that's essentially if an athlete plants their foot in and pivots, does the shoe release or does it stick in the turf? And if it sticks, you have lower extremity injuries in the knees or ankles or things like that. We're seeing that with the most aggressive cleats, we get high levels of traction that could have potential for injuries. Differences in shoes are much larger than the difference in natural or synthetic turf. That's a big part of research, screening the shoes that are out there. We don't really have a magic number right now saying one is safe or not safe, but what we can do is relative comparisons among the shoes.

AM: Then we try to get that information out to coaches and athletes, trainers, so they can make those wise consumer choices.

TS: Another ongoing thing we're doing is durability testing. We have a machine that can simulate 10 to 20 years in just a few weeks or a month or so. It's a table top machine with cleats on it that they roll back and forth as the turf moves side to side underneath. We can screen certain products to see how the fibers break down over time. When we first started this, the products out there tended to break down rather quickly, whereas the products out there now, are showing a lot more durability, so that's another thing we are screening. We solicit samples from field managers or the field owners themselves. They can contact us to see if we need a certain sample of a type of field on our website. Another thing is different tests for surface temperature, surface hardness, and evaluating organic infills in terms of traction and hardness. And what happens over time, do they get moldy or excessively hard? Because we know the market is looking at things alternative to crumb rubber.

AM: And we're continuing to do some baseball bounce work, to increase or decrease the speed of that ball bounce. Messing around now with how much fiber is exposed and how much traction that gives. Some research at the University of Virginia is saying that infill depth has a relation to traction.

AM: And if you have any other questions let Tom or I know.